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(71) Applicant: 000003001
Teijin Ltd.
1-6-7 Minami-honmachi, Chuo-ku, Osaka-shi, Osaka Prefecture

(72) Inventor: Seiji TSUBOI
Matsuyama Plant
Teijin, Ltd.
77 Kita-yoshida-machi, Matsuyama-shi, Ehime Prefecture

(72) Inventor: Mitsuo MATSUMOTO
Matsuyama Plant
Teijin, Ltd.
77 Kita-yoshida-machi, Matsuyama-shi, Ehime Prefecture

(74) Agent: 100077263
Sumihiro MAEDA, a registered patent attorney

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(54) Title of the Invention: POLYESTER BICOMPONENT FIBER AND METHOD OF MANUFACTURING THE SAME

(57) Summary

Object: To provide a polyester bicomponent fiber which has good weavability and is highly suitable for obtaining woven cloth endowed with an excellent stretch and sense of fullness.

Solution: A polyester bicomponent fiber prepared by bicomponent spinning poly(trimethylene terephthalate) having an intrinsic viscosity of 0.9 to 1.5 with poly(ethylene terephthalate) having an intrinsic viscosity of 0.3 to 0.7 in a weight ratio of 3:7 to 7:3 and a side-by-side or eccentric sheath-core arrangement, which fiber has a visible crimp of at most 15% and a total crimp of 20 to 50%.

SPECIFICATION

Claims

(1) A polyester bicomponent fiber comprising a poly(trimethylene terephthalate)-based polyester A of 0.9 to 1.5 intrinsic viscosity and a poly(ethylene terephthalate)-based polyester B of 0.3 to 0.7 intrinsic viscosity that are joined in a side-by-side or eccentric sheath-core arrangement, which fiber has a visible crimp of at most 15% and a total crimp of 20 to 50%.

(2) The polyester bicomponent fiber of claim 1, wherein the poly(trimethylene terephthalate) polyester A and the poly(ethylene terephthalate) polyester B have an intrinsic viscosity difference of 0.4 to 0.8.

(3) A method of manufacturing polyester bicomponent fibers, the method being comprised of bicomponent spinning a poly(trimethylene terephthalate)-based polyester A of 0.9 to 1.5 intrinsic viscosity and a poly(ethylene terephthalate)-based polyester B of 0.3 to 0.7 intrinsic viscosity in a weight ratio (A:B) of 30:70 to 70:30 and a side-by-side or eccentric sheath-core arrangement; then hauling off the spun filament at a speed of 4,000 to 8,000 m/min.

Detailed Description of the Invention

[0001]

Field of Industrial Use:

The present invention relates to polyester bicomponent fibers in which the components have been arranged in a side-by-side or eccentric sheath-core configuration. More specifically, it relates to a polyester bicomponent fiber which is composed of a poly(ethylene terephthalate)-based polyester and a poly(trimethylene terephthalate)-based polyester, and which has a good weavability and can be used to obtain woven cloth endowed with an excellent stretch and sense of fullness.

[0002]

Prior Art:

Bicomponent fibers composed of poly(trimethylene terephthalate) and poly(ethylene terephthalate) bonded together in a side-by-side configuration are known to have excellent latent crimp developability. Moreover, woven goods that have been woven from such fibers, then heat-treated to develop crimps are known to have both a stretch and a sense of fullness that are much better than those of other polyester bicomponent fibers (see, for example, JP-A 11-189923 and 11-158733).

[0003]

Yet, although the bicomponent fibers disclosed in the above published specifications have excellent crimp developability (e.g., total crimp, expressed in percent) when heat treated, the degree of crimp that develops in the fibers during yarnmaking (visible crimp, expressed in percent) also tends to be quite high, compromising the ease of yarn passage through the loom during weaving and thus making stable weaving difficult to achieve.

[0004]

One conceivable way for resolving this problem is a method which attempts to reduce the visible crimp by lowering the draw ratio and thus suppressing orientation. However, even if it succeeds in reducing visible crimp, such a method fails to yield fibers having sufficient degree of total crimp, thus making it impossible to achieve a woven fabric endowed with a high stretch and a sense of fullness. Moreover, fibers obtained by such a method also have inadequate mechanical qualities such as tenacity.

[0005]

Another conceivable method involves adjusting the intrinsic viscosities of poly(trimethylene terephthalate) and poly(ethylene terephthalate). However, as with the method described above, this approach too may succeed in lowering the degree of visible crimp, but fails to provide a sufficiently high total crimp.

[0006]

Problems to be Resolved:

The present invention was arrived at in light of the above-described prior-art. One object of the invention is to provide novel polyester bicomponent fibers having good weavability and capable of forming woven fabric endowed with excellent stretch and sense of fullness. Another object of the invention is to provide a method of manufacturing such fibers.

[0007]

Means for Resolving the Problems:

Based on research they conducted, the inventors have discovered that the first object set forth above can be achieved by a polyester bicomponent fiber made of a poly(trimethylene terephthalate)-based polyester A of 0.9 to 1.5 intrinsic viscosity and a poly(ethylene terephthalate)-based polyester B of 0.3 to 0.7 intrinsic viscosity that are joined in a side-by-side or eccentric sheath-core arrangement, which fiber has a visible crimp of at most 15% and a total crimp of 20 to 50%.

[0008]

Moreover, the inventors have discovered that the other object mentioned above can be achieved by a method of manufacturing polyester bicomponent fibers which includes the steps of bicomponent spinning a poly(trimethylene terephthalate)-based polyester A of 0.9 to 1.5 intrinsic viscosity and a poly(ethylene terephthalate)-based polyester B of 0.3 to 0.7 intrinsic viscosity in a weight ratio (A;B) of 30:70 to 70:30 and a side-by-side or eccentric sheath-core arrangement; then hauling off the spun filament at a speed of 4,000 to 8,000 m/min.

[0009]

Mode for Carrying Out the Invention:

The mode for carrying out the invention is described in detail below. The poly(trimethylene terephthalate)-based polyester A used in the invention is a polyester in

which trimethylene terephthalate units are the main recurring units. The poly(ethylene terephthalate)-based polyester B is a polyester in which ethylene terephthalate units are the main recurring units.

[0010]

Polyesters A and B may have copolymerized therein a third component in an amount that does not compromise the objects of the invention, such as not more than 15 mol %, and preferably not more than 5 mol %, based on the acid component. Preferred examples of such copolymerizing components include acids such as isophthalic acid, succinic acid, adipic acid, 2,6-naphthalenedicarboxylic acid, 5-sulfoisophthalic acid sodium salt, and the tetrabutylphosphonium salt of 5-sulfoisophthalic acid; glycols such as 1,4-butanediol, 1,6-hexanediol, and cyclohexanedimethanol; and ε-caprolactone, 4-hydroxybenzoic acid, polyethylene glycol, and polytetramethylene glycol.

[0011]

If necessary, various additives may be included in above polyesters A and B by copolymerization or admixture. Illustrative examples of such additives include delusterants, heat stabilizers, antifoaming agents, bluing agents,* fire retardants, antioxidants, ultraviolet absorbers, infrared absorbers, crystal nucleating agents and phosphorescent whiteners.

[0012]

In addition, it is necessary to set the intrinsic viscosity of the above-described poly(trimethylene terephthalate)-based polyester A within a range of 0.9 to 1.5, and preferably 1.0 to 1.2, and to set the intrinsic viscosity of the poly(ethylene terephthalate)-based polyester B within a range of 0.3 to 0.7, and preferably 0.4 to 0.6. A poly(trimethylene terephthalate)-based polyester A having an intrinsic viscosity of less than 0.9 does not generate sufficient shrinkage stress for this component, making it difficult to obtain a high-stretch bicomponent fiber. Such an polyester A is undesirable as well because it results in a large change over time in the manufactured yarn, and also lowers the fiber strength and the crimp properties. Conversely, at an intrinsic viscosity greater than 1.5, the ease of fiber formation declines, resulting in poor spinning conditions. A poly(ethylene terephthalate)-based polyester B having an intrinsic viscosity of less than 0.3 has too low a molecular weight, reducing the fiber strength. On the other hand, at a polymer molecular weight of more than 0.7, the crimp performance (total crimp) suffers.

[0013]

In the practice of the invention, it is desirable to have the intrinsic viscosity difference between polyesters A and B be at least 0.4 so as to achieve higher crimp and a more stable crimp shape. At the same time, this difference is held to not more than 0.8 so as to control interfacial separation between polyesters A and B, and also to suppress "kneeing," or curling of the extrudate toward the high melt viscosity side just below the

* Translator's Note: Unconfirmed rendering of the Japanese seishokuzai.

spinneret openings during spinning. Thus, an intrinsic viscosity difference within a range of 0.4 to 0.8, and especially 0.5 to 0.7, is preferred.

[0014]

In the invention, the poly(trimethylene terephthalate)-based polyester A and the poly(ethylene terephthalate)-based polyester B are joined in a side-by-side or eccentric sheath-core arrangement to form a bicomponent fiber.

[0015]

Polyesters A and B are combined in a weight ratio (A:B) of 30:70 to 70:30, and preferably 40:60 to 60:40. If the poly(trimethylene terephthalate)-based polyester serving as component A is present in a proportion greater than 70 wt %, the crimp performance (total crimp) improves, but the bicomponent fiber tends to have a poor strength. On the other hand, a high crimp performance is difficult to achieve at a component A proportion of less than 30%.

[0016]

To impart the polyester bicomponent fiber of the invention with both good weavability and the ability to confer to the final textile product obtained therewith, such as woven cloth, an excellent stretch and excellent sense of fullness, it is critical for the inventive fiber to have a visible crimp of at most 15%, and preferably at most 10%, and to have a total crimp in a range of 20 to 50%, and preferably 30 to 40%. That is, in prior-art polyester bicomponent fibers, attempts to obtain fibers having a high total crimp result also in a high visible crimp, which is detrimental to the weavability. Research results obtained by the inventors have shown that the yarnmaking method described below provides bicomponent fibers composed of poly(trimethylene terephthalate)-based polyester and poly(ethylene terephthalate)-based polyester which are able to simultaneously satisfy the above conditions concerning visible crimp and total crimp, and which can be used to stably weave cloth that exhibits excellent stretch and a good sense of fullness.

[0017]

Here, at a visible crimp greater than 15%, the number of crimps becomes too high, reducing the ease of passage through guides in the loom, and thus making weaving more difficult to carry out. On the other hand, at a total crimp below 20%, woven cloth and other textile products made therewith have decreased stretch and a poor sense of fullness characterized by a paper-like hand. Moreover, a total crimp of more than 50% makes production difficult, and is thus undesirable.

[0018]

The above-described polyester bicomponent fibers of the invention can be produced by the following method. Poly(trimethylene terephthalate)-based polyester A having an intrinsic viscosity of 0.9 to 1.5 and poly(ethylene terephthalate)-based polyester B having an intrinsic viscosity of 0.3 to 0.7 is melt-spun at a melt spinning temperature of 270 to 290°C and a relative weight ratio for the two components within the above-

indicated range using a prior-art spinneret for producing side-by-side or eccentric sheath-core bicomponent fibers. The discharged filaments are solidified by blowing cooling air across them, then hauled off at a speed of 4,000 to 8,000 m/min, and preferably 5,000 to 6,500 m/min. If necessary, the filaments can then be directly drawn and heat treated without first being wound up. The number of rollers used for haul-off is not subject to any particular limitation. A single roller, or a plurality of two or more rollers may be used for this purpose, although the filaments are generally hauled off by way of a pair of rollers. The rotational speeds (circumferential speeds) of the first and second rollers at this time may be allowed to differ within a range that does not reduce the spinning stability or compromise the objects of the invention, although the two rollers are usually rotated at the same speed.

[0019]

Operation of the Invention:

In the polyester bicomponent fibers of the invention, because the high-viscosity poly(trimethylene terephthalate)-based polyester A with an intrinsic viscosity of 0.9 to 1.5 has a larger thermal shrinkage than the low-viscosity poly(ethylene terephthalate)-based polyester B with an intrinsic viscosity of 0.3 to 0.7, when subjected to heat treatment, the fiber develops a high degree of crimp with polyester A situated on the inside of the crimps and polyester B on the outside. Moreover, because this bicomponent fiber is hauled off at a high speed of at least 4,000 m/min, although the reason why is not clear, the resulting bicomponent fiber has less visible crimp prior to heat treatment than does conventional drawn fiber obtained from undrawn fiber spun at a low speed, and can thus be stably woven.

[0020]

In addition, because the high-viscosity side of the bicomponent fiber is made of poly(trimethylene terephthalate)-based polyester, in contrast with bicomponent fibers having the opposite viscosity relationship, the low-viscosity side is made of poly(ethylene terephthalate)-based polyester. Hence, the inventive bicomponent fiber suppresses the change over time that arises when the low-viscosity side is poly(trimethylene terephthalate)-based polyester.

[0021]

Examples:

The invention is illustrated more fully in the following examples. Measurements forming the basis of evaluations in the examples were carried out as described below.

[0022]

(1) Intrinsic Viscosity

Measured by a conventional method using o-chlorophenol as the solvent and at 35°C.

[0023]

(2) Elongation at Break, and Tenacity

Measured using an Autograph/Tensile Tester manufactured by Shimadzu Corporation at a yarn specimen length of 200 mm and a test rate of 200 mm/min. Results indicated are the average of three measurements (N=3).

[0024]

(3) Elastic Recovery from 10% Extension

The filament was mounted in a tensile tester at a chuck interval of 250 mm and extended 10% at a pull rate of 50 mm/min, then returned to its original length (L_0) at the same rate. The distance moved (L) while stress was applied to the filament was read off, and the elastic recovery was calculated as follows.

$$\text{Elastic recovery (\%)} = L/25 \times 100$$

[0025]

(4) Visible Crimp (VC) and Total Crimp (TC)

A skein was prepared by setting the number of revolutions [on a reel] such as to give a total linear density of 3330 dtex. A load of 5.88 cN (6 g) was applied to this skein, following which a load of 2.94 N (300 g) was additionally applied. The length at this time was recorded as L_0. The 2.94 N (300 g) load was then removed, and the length after 1 minute under the 5.88 cN (6 g) load was recorded as L_1. Next, without removing the 5.88 cN (6 g) load, the skein was placed in boiling water for 20 minutes. The skein was then removed from the water and thoroughly dried, after which a load of 2.94 N (300 g) was applied, and the resulting length recorded as L_2. The 5.88 cN (6 g) load was then removed, and the length under a load of 5.88 cN (6 g) was recorded as L_3. The visible crimp (VC) and total crimp (TC) were determined from the following formulae.

$$\text{VC (\%)} = (L_0 - L_1)/L_0 \times 100$$

$$\text{TC (\%)} = (L_2 - L_3)/L_0 \times 100$$

[0026]

(5) Boiling Water Shrinkage (BWS)

A load of 0.09 cN/dtex, based on the total linear density, was applied to a 200 mm skein prepared from ten revolutions of the filament, and the resulting length was recorded as L_0. Next, the skein was immersed in a no-load state in 100°C boiling water for 30 minutes. After thorough drying, the length of the skein when subjected again to the same load was recorded as L_1. The percent shrinkage of the skein after boiling water treatment relative to before treatment was calculated below as the boiling water shrinkage (BWS).

$$\text{BWS (\%)} = (L_0 - L_1)/L_0 \times 100$$

[0027]

(6) Percent Stretch of Woven Fabric

A woven fabric specimen having a length of 150 mm and a width of 50 mm was mounted in a tensile tester under an initial load of 196 mN (20 g) and a chuck interval of 100 mm, following which the extension under a load of 14.7 N (1.5 kg) was calculated from the following formula. The passing value was 15% or higher.

$$\text{Percent stretch} = L/100 \times 100$$

[0028]

(7) Sense of Fullness

Sensory tests were conducted using a panel of ten persons selected at random. The specimens were rated as Good, Fair or Poor.

[0029]

Working Example 1

Chips of poly(trimethylene terephthalate) having an intrinsic viscosity of 1.05 and chips of poly(ethylene terephthalate) having an intrinsic viscosity of 0.4 were fed to a bicomponent spinning machine in a weight ratio A:B of 50:50, and melt-spun from a spinneret for making side-by-side bicomponent filament at a temperature of 280°C. The discharged filament was hauled off at a speed of 5,500 m/min, yielding 83.3 dtex 24 filament bicomponent yarn. The physical properties, visible crimp (VC) and total crimp (TC) of the resulting bicomponent fiber, and the hand of woven fabric made from the fiber are shown below in Table 1.

[0030]

Comparative Example 1

Chips of poly(trimethylene terephthalate) having an intrinsic viscosity of 1.05 and chips of poly(ethylene terephthalate) having an intrinsic viscosity of 0.4 were fed to a bicomponent spinning machine in a weight ratio A:B of 50:50, and melt-spun from a spinneret for making side-by-side bicomponent filament at a temperature of 270°C. The discharged filament was hauled off at a speed of 3,000 m/min, yielding 133 dtex 24 filament undrawn bicomponent yarn. This undrawn filament was drawn at a preheating temperature of 80°C and a setting temperature of 180°C, yielding 82.1 dtex 24 filament bicomponent yarn. The physical properties, visible crimp (VC) and total crimp (TC) of the resulting bicomponent fiber, and the hand of woven fabric made from the fiber are shown below in Table 1.

[0031]

Comparative Example 2

Chips of poly(trimethylene terephthalate) having an intrinsic viscosity of 1.05 and chips of poly(ethylene terephthalate) having an intrinsic viscosity of 0.5 were fed to a bicomponent spinning machine in a weight ratio A:B of 50:50, and melt-spun from a spinneret for making side-by-side bicomponent filament at a temperature of 270°C. The discharged filament was spin-drawn (direct draw process) by way of a first roller having a speed of 1,500 m/min and a temperature of 80°C and a second roller having a speed of 4,000 m/min and a temperature of 205°C, yielding 83.1 dtex 24 filament bicomponent yarn. The physical properties, visible crimp (VC) and total crimp (TC) of the resulting bicomponent fiber, and the hand of woven fabric made from the fiber are shown below in Table 1.

[0032]

Table 1

	Visible crimp (%)	Total crimp (%)	Tenacity (cN/dtex)	Elongation (%)	Boiling water shrinkage	Weav-ability	Stretch (warp/filling)	Sense of fullness
Working Ex. 1	8.5	32.0	3.62	33.5	7.5	good	20/27	good
Comp. Ex. 1	42.7	38.2	3.62	27.6	11.3	poor	27/29	good
Comp. Ex. 2	29.6	40.2	3.71	30.3	12.1	fair	29/34	good

[0033]

Advantages of the Invention

The polyester bicomponent fibers of the invention have a low visible crimp, giving them excellent weavability. At the same time, because they have a sufficiently large total crimp, woven fabrics endowed with excellent stretch and a good sense of fullness can be obtained from these fibers without having to carry out heat treatment after weaving. Such fibers can be used in a broad range of applications requiring stretch properties, including both sportswear and outer wear.

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F. Metreaud
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